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Increased frequency of involuntary semantic memories or mind-pops in schizophrenia: a diary study

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Introduction: Hallucinations constitute a prominent symptom of schizophrenia and may take a variety of forms (verbal, visual, musical, or environmental noises). Interesting similarities exist between hallucinations and so-called *mind-pops* which refer to isolated fragments of one's semantic knowledge (e.g., a word/sentence, visual image, or a song/melody) that come to mind unexpectedly, often without any obvious triggers, and are difficult to control. The aim of the present study was to evaluate whether mind-pops may constitute the raw cognitive material from which hallucinations are constructed by studying the nature and frequency of mind-pops in the everyday life of people with schizophrenia and non-clinical controls. **Methods:** Eleven participants with schizophrenia and 14 non-clinical controls kept a diary of their mind-pops for seven days and completed a brief questionnaire every time they had a mind-pop.

Results: Schizophrenia participants reported significantly more verbal and image mind-pops than controls and their content was negative more often than in controls. No group differences were obtained in terms of reported triggers or ongoing activities. Data from both groups also supported the priming hypothesis by showing that stimuli encountered in one's environment or thoughts could later re-appear in the form of a mind-pop.

Conclusions: The findings have implications for models of schizophrenia that emphasise the role of intrusive thoughts and memories in the aetiology and development of key psychotic symptoms.

Keywords: schizophrenia; hallucinations; auditory verbal hallucinations; involuntary semantic memories; mind-pops

Introduction

Hallucinations are one of the most prominent symptoms of schizophrenia (David, 2004; Jones, 2010). Although research has focused primarily on hearing voices or auditory verbal hallucinations (AVHs), reports of non-verbal auditory hallucinations (music, laughter, crying) and visual hallucinations (VHs) are also common (McCarthy et al., 2014; Nayani & David, 1996; Oorshot et al., 2012; Waters et al., 2014). Several studies have demonstrated a large variability in the nature and complexity of AVHs, ranging from single words and sentences/abusive comments to whole conversations (McCarthy et al., 2014; Nayani & David, 1996; Stephane, Thuras, Nasrallah, &

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Georgopoulos, 2003). Similar diversity has also been noted for VHs, and the co-occurrence of AVHs and VHs in schizophrenia suggests that there may be a common causal mechanism for these phenomena (Waters et al., 2014).

What is the raw cognitive material that hallucinations consist of, and where does their actual content come from? Potential candidates have included inner speech (Jones, 2010), intrusive thoughts (Morrison, Haddock, & Tarrier, 1995) and episodic memories without contextual detail (Waters, Badcock, Michie, & Maybery, 2006).

Recently, however, a new cognitive phenomenon has been described, which has striking similarities with the diverse manifestations of hallucinatory experiences (Elua, Laws, & Kvavilashvili, 2012). This phenomenon, termed involuntary semantic memories or *mind-pops*, and experienced by majority of people, refers to fragments of semantic knowledge (words, phrases, images and songs) that unexpectedly pop into mind, often without obvious external/internal triggers (Kvavilashvili & Mandler, 2004). For example, a person may be having a breakfast, and thinking about visiting a friend, when a word (e.g., *miracle*), someone's name or a saying (e.g., *Vladimir Lenin* or *the rain in Spain stays mainly in the plain*), a visual image (e.g., *St. Paul's Cathedral*) or a song/melody pops into their mind.

Initial research on mind-pops in non-clinical samples, using questionnaire and diary methods, suggested that mind-pops may not be such random occurrences as they initially seem (Kvavilashvili & Mandler, 2004). In almost 50% of recorded mind-pops, participants indicated that the content had been encountered recently (from minutes to several weeks ago). This gave rise to the long-term priming hypothesis, suggesting that representations of myriad stimuli encountered in everyday life may remain active in one's network of semantic knowledge for days or weeks. Subsequent re-activations of these concepts by chance encounters with other related stimuli may result in sudden conscious experience of a *mind-pop* (see also Coane & Balota, 2009).¹

Elua et al. (2012) proposed that mind-pops may represent *the raw cognitive material* from which hallucinations are constructed in schizophrenia. Using a brief, four-item Mind-Popping Questionnaire (Kvavilashvili & Mandler, 2004), they found that self-reported frequency of mind-pops was significantly higher in participants diagnosed with schizophrenia, than in either clinically depressed or control participants, who did not differ from each other. This indicates that mind-pops may be specifically linked to schizophrenia rather than clinical populations in general. Results also showed that an increased tendency for mind-pops may be a trait characteristic of schizophrenia rather than related to concurrent hallucinatory experiences, as the frequency ratings were not significantly different in schizophrenia patients with and without hallucinations at the time of the study.

The aim of the present study was to extend these initial findings using a diary method with schizophrenia and control groups, who completed a brief questionnaire page each time they experienced a mind-pop during a seven-day recording period.

Method

Participants

Thirteen individuals diagnosed with schizophrenia, using DSM-IV criteria (American Psychiatric Association, 1994), were recruited from a Day Treatment Programme for chronically mentally ill individuals. Two participants did not complete a diary,

resulting in 11 participants (7 males, 4 females). All participants attended daily treatment sessions and activities at the programme (9:00 am to 2:30 pm). In addition, five participants were employed part-time, and one was a part-time college student. Non-clinical controls were 14 female support staff and psychotherapists from the outpatient clinic, who were blind to the aims and hypothesis of the study. For background details of the two groups, see [Table 1](#).

Prior to the study, the diagnoses were confirmed in independent clinical interviews by a licensed clinician (the first author). Out of 11 schizophrenia participants, 6 experienced delusions and AVHs, 2 experienced hallucinations only (one person – AVHs, and another – VHs). The remaining three patients did not experience psychotic symptoms at the time of participation, however, two of them had a history of delusions, and one had a history of AVHs. All patients were receiving anti-psychotic medications.

Materials and procedure

A *mind-popping diary* consisted of an A5 size booklet with 32 double-sided pages, containing a nine-item questionnaire on each side (see [Table 2](#) for a mind-popping diary page). Each participant was provided with definitions and everyday examples of involuntary autobiographical memories and semantic mind-pops. Participants were asked to keep a diary of their mind-pops only. It was emphasised that there was no minimum or maximum number of mind-pops that one could record. Participants had to carry the diary with them at all times and record mind-pops as soon as possible after their occurrence. If by the time they could record a mind-pop, they had forgotten some essential details, the mind-pop still had to be acknowledged by a check mark on the inner cover page of the diary. Detailed instructions about answering each question on a diary page were provided orally and on the back cover page of the diary (see an online supplemental file). Participants started recording mind-pops immediately after meeting with the researcher, and returned diaries after seven days. Clinical participants received \$20 for their participation.

Table 1. Descriptive statistics for background variables (age, Mini-Mental State Examination scores and years of education) in schizophrenia and control groups, and results of one-way analysis of variances (ANOVAs) on the means.

Variables	Schizophrenia ($N = 11$)	Controls ($N = 14$)	$F(1,23)$	p -Value
<i>Age</i>				
Mean	45.55	44.93	.02	.89
SD	(7.90)	(12.61)		
Range	31–62	24–61		
<i>MMSE scores</i>				
Mean	28.09	28.79	1.66	.21
SD	(1.45)	(1.25)		
Range	26–30	26–30		
<i>Education (years)</i>				
Mean	14.64	17.21	3.50	.07
SD	(4.20)	(2.66)		
Range	8–22	13–20		

Table 2. Questions of the mind-popping diary page.

-
1. When did you have the mind-pop? Date: _____ Time: _____ a.m./p.m.
 2. When did you record it? Date: _____ Time: _____ a.m./p.m.
 3. What was the content of your mind-pop?
 4. What were you doing when you had the mind-pop?
 5. How much were you concentrating on this activity? (Circle as appropriate):
 - 1 = not concentrating at all;
 - 2 = slightly concentrating;
 - 3 = moderately concentrating;
 - 4 = considerably concentrating;
 - 5 = fully concentrating;
 6. Where were you when you had this mind-pop?
 7. Was the mind-pop triggered by something? (Circle as appropriate):
 - (a) in your thoughts;
 - (b) in your environment;
 - (c) there was no trigger (if so, go to Question 9)
 8. What was the trigger?
 9. Has the content of this mind-pop been encountered (either in your environment or your thoughts) recently? **Yes/No** (circle as appropriate)
- If "Yes", then when and where (how) did you encounter this content?
- When:**
- Where (how):**
-

Results

All participants kept a diary for one week.² The descriptions of mind-pops (content, type, valence) and activities (controlled vs. automatic) were coded by IE and LK with agreements ranging from 92% (for coding descriptions as a mind-pop or not) to 100% (for classifying the content as a word, image or music). Disagreements were solved by discussion. Because numbers of recorded mind-pops were not normally distributed, square root transformations were applied when conducting parametric analyses.

Total number of recorded mind-pops

One control reported not experiencing any mind-pops, and the remaining 13 recorded 55 mind-pops. All schizophrenia participants made at least one diary entry, and recorded 250 mind-pops.³ We excluded 26 entries that represented involuntary autobiographical memories (e.g., memory of being nearly hit by a car) or other contents (e.g., daydreams), leaving a total of 51 mind-pops in the control group ($M = 3.92$, $SD = 2.47$; range 1–10), and 228 in the schizophrenia group ($M = 20.73$, $SD = 15.85$, range = 1–56). The difference between these means was highly significant $F(1,22) = 16.66$, $MSE = 1.85$, $p = .0004$, $\eta_p^2 = .43$.

Types of recorded mind-pops

The descriptions of mind-pops fell into three categories: verbal (words, phrases, proper names), visual (images) and musical (songs/melodies). The mean numbers of verbal,

visual and musical mind-pops were entered into a 2 group (schizophrenia vs. control) \times 3 mind-pop (word vs. image vs. melody) mixed ANOVA. The main effects of group ($F(1,22) = 15.10$, $MSE = 1.76$, $p = .001$, $\eta_p^2 = .41$), and mind-pop ($F(2,44) = 4.55$, $MSE = 0.94$, $p = .016$, $\eta_p^2 = .17$) were qualified by a significant interaction ($F(2,44) = 4.00$, $MSE = 0.94$, $p = .025$, $\eta_p^2 = .15$) (see Figure 1). Tests of simple main effects showed that in comparison to the control group, schizophrenia patients recorded more words ($F(1,22) = 10.59$, $p = .004$, $\eta_p^2 = .33$) and visual images ($F(1,22) = 11.47$, $p = .003$, $\eta_p^2 = .34$), but the number of recorded melodies did not significantly differ between the groups ($p = .32$). In addition, a significant main effect of type of mind-pop was present in schizophrenia patients ($F(1,21) = 12.92$, $p = .0002$, $\eta_p^2 = .55$) but not in the control group ($F < 1$). Thus, schizophrenia patients recorded more words and images than melodies ($p = .0002$ and $p = .005$, respectively), but the difference between the words and images was not significant ($p = .39$).

Mind-pops with negative content

Examples of mind-pops that were coded as negative included words, phrases and proper names such as “suicide,” “knife,” “dead fish,” “you’re not keeping up” or “Hitler,” and visual images of “a dead crow,” “a body part in bandages” or “hospital with doctors/nurses.” In the schizophrenia group, 16% of recorded mind-pops (37/228) had a negative content, in comparison to 8% (4/51) in the control group, but this difference was not significant $\chi^2(1,279) = 2.34$, $p = .13$. However, nine schizophrenia participants (82%) recorded at least one negative mind-pop (range 1–19), but only four

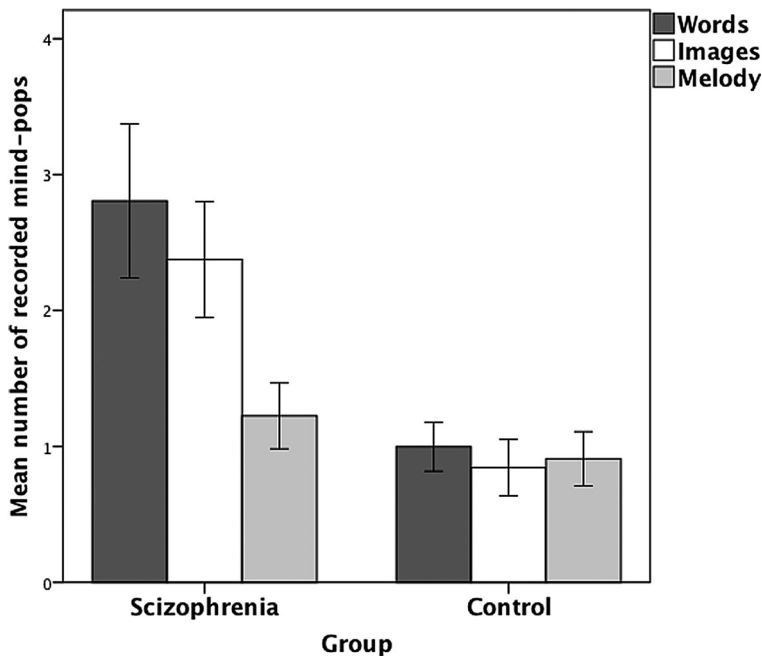


Figure 1. Mean number of types of mind-pops (square root transformed) for schizophrenia and control groups. Error bars represent ± 1 standard error.

control participants (31%) recorded one negative mind-pop each, $\chi^2(1, 24) = 6.25$, $p = .012$, indicating that the likelihood of having a negative mind-pop is higher in the schizophrenia than the control group.

Reported triggers for mind-pops

The analyses reported below are based on 202 mind-pops (instead of 228) in the schizophrenia group because two participants recorded only the contents of mind-pops, but did not complete the questionnaire pages (see footnote 2). There were no group differences in the percentage of identified triggers, $\chi^2 < 1$, with almost half of recorded mind-pops reported as having no “known” triggers (48% in the schizophrenia and 47% in the control group). The remaining mind-pops were reported to have either external (27%) or internal triggers in one’s thoughts (25%).

Ongoing activities, places and concentration ratings

Mind-pops were reported to occur during habitual activities such as brushing teeth or walking (63.4% in the schizophrenia and 62.7% in the control group), rather than during cognitively demanding tasks such as writing or working at the till (36.6% in the schizophrenia and 37.3% in the control group), $\chi^2 < 1$. Also, in both groups, the majority of mind-pops were reported at places associated with undemanding leisure activities such as at home (49%) or travelling (12%), $\chi^2 < 1$ (see Table 3). However, the mean ratings of concentration on these activities (on a five-point scale with three indicating medium concentration) were higher in the schizophrenia ($M = 2.99$, $SD = 0.85$) than in the control group ($M = 2.21$, $SD = 0.74$), $F(1,20) = 5.36$, $MSE = 0.62$, $p = .03$, $\eta_p^2 = .21$.

Presence/absence of a prime for the reported mind-pop

Schizophrenia participants indicated that the content of the mind-pop had been encountered in the past (in identical or altered form) on 42% of occasions. In the control group, such priming was reported on 45% of occasions ($\chi^2 < 1$). The time scale between encountering a prime and experiencing a mind-pop was between 30 minutes to two months. Examples included a word “fibromyalgia” heard in a

Table 3. Percentage of mind-pops (raw numbers) in schizophrenia and control groups as a function of places where they occurred.

Places where mind-pops were recorded to have occurred					
Group	Home	Street and transport	Clinic and work place	Other	Total
Schizophrenia	50% (101)	10% (20)	33% (66)	7% (15)	100% (202)
Control	45% (23)	22% (11)	29% (15)	4% (2)	100% (51)
Total	49% (124)	12% (31)	32% (81)	7% (17)	100% (253)

Notes: For controls, treatment facility (i.e., clinic) was the place of their work. For group with schizophrenia, 34 mind-pops out of 202 (17%) were recorded in the treatment facility and 32 (16%) were recorded at the work place/college.

doctor's office few weeks ago, the film title "Tarzan of the Apes" that the participant watched on a previous day, and the song "Happy Birthday Mr. President," which was primed by seeing a picture of Marilyn Monroe in a newspaper a day before.

Discussion

Several novel findings emerged from the study, which extend the initial results of Elua et al. (2012), and have important implications for research in schizophrenia by suggesting intriguing similarities between mind-pops and hallucinations. In terms of frequency, significant group differences emerged with schizophrenia participants recording five times more mind-pops than the control group. In addition, schizophrenia patients reported significantly more verbal and visual mind-pops than controls, but groups did not differ in the number of musical mind-pops.

The increased numbers of both verbal and visual mind-pops in schizophrenia patients is in line with the Oorshot et al. (2012) experience sampling study, which demonstrated that 52% of hallucinating patients with schizophrenia spectrum disorder reported both verbal and VHs (see also Delespaul, de Vries, & van Os, 2002). This suggests that schizophrenia patients may be generally vulnerable to experiencing verbal and visual intrusions. In contrast, musical hallucinations have been reported in smaller percentage of schizophrenia patients (36%, see Nayani & David, 1996), and this, again, was mirrored in our study with schizophrenia group reporting significantly fewer musical than verbal and visual mind-pops.

Moreover, the contents of verbal and visual mind-pops showed phenomenological similarities to both AVHs and VHs. For example, the content of AVHs varies from single words, to more complex phrases/sentences and even whole conversations (McCarthy-Jones et al., 2014; Stéphane et al., 2003). Descriptions of mind-pops by schizophrenia patients also consisted of single words (e.g., *butterfly*, *marihuana*) and phrases (e.g., "don't go to Manhattan," "one thousand hours"). Given that AVHs are often experienced inside one's head and can lack perceptual qualities of real voices (Hoffman, Varanko, Gilmore, & Mishara, 2008; Moritz & Larøi, 2008; Nayani & David, 1996), there appears to be a thin line between verbal mind-pops and AVHs that consist of words and phrases. Similarly, complex VHs in schizophrenia often consist of images of faces, animals, objects or scenes (Waters et al., 2014) and the visual mind-pops in the present study also consisted of images of "Tom Hanks," "a neighbour's dog," "an MP3 player," "Botanical Gardens in Bronx." In addition, the content of hallucinations in schizophrenia tends to be negative and derogatory (McCarthy-Jones et al., 2014; Waters et al., 2014) and, in line with this, our findings showed that whereas mind-pops with negative content were extremely rare for controls, 83% of schizophrenia patients reported at least one negative mind-pop.

It is also important that in both groups, almost half of all mind-pops (48%) were reported to have no apparent triggers, which may contribute to the perception of them being "alien" and "uncontrollable," characteristics that have often been ascribed to experience of hallucinations in schizophrenia (David, 2004; Larøi & Woodward, 2007). Furthermore, both groups were more likely to report experiencing mind-pops during fairly undemanding activities, which is broadly consistent with previous reports of hallucinations being experienced more frequently or intensely when alone and/or unoccupied (Nayani & David, 1996; Tarrier, 1987).

Finally, our results showed that in 42–45% of recorded mind-pops, participants were able to identify recent occasions in which they had encountered the contents of their mind-pop. This finding accords with the long-term priming hypothesis (Kvavilashvili & Mandler, 2004), and is in agreement with the results of McCarthy-Jones et al. (2014), who found that 43% of schizophrenia patients reported the contents of their AVHs being identical or similar (in gist) to past memories. Thus, the contents of both mind-pops and hallucinations may be in a state of increased activation through recent encounters with identical or similar material, enhancing the chances of later intrusion into the consciousness (see Beck & Rector, 2003).

One clear limitation of the present study is the small sample size and future research needs to test larger samples that are closely matched for gender and years of education. It should be noted, however, that despite group differences in years of education approaching significance (see Table 1), all schizophrenia participants scored within normal range on Mini-Mental State Examination (MMSE, Folstein, Folstein, & McHugh, 1975). It is also important that all schizophrenia patients attended daily sessions at the Treatment Programme and, 6 out of 11, were in part-time employment/education. This reduces the possibility that the increased number of mind-pops in schizophrenia patients was due to them being occupied in fewer or less demanding activities than the control group. Table 3 shows that similar percentages of mind-pops were recorded in both groups at places where people are usually engaged in less demanding leisure activities (home and street/transport). If anything, schizophrenia participants reported significantly higher levels of concentration on these activities at the time of experiencing their mind-pops.

In conclusion, our results confirm important similarities between hallucinations and mind-pops in terms of both phenomenology and conditions in which they occur. Long-term priming processes underlying mind-pops (irrespective of their type) indicate that similar cognitive mechanisms may be in operation for auditory, visual and musical hallucinations, emphasising the importance of developing more integrative models of hallucinations in schizophrenia.

Disclosure statement

No potential conflict of interest was reported by the authors.

Supplemental data and research materials

Supplemental data for this article can be accessed at [10.1080/13546805.2015.1092431](https://doi.org/10.1080/13546805.2015.1092431).

Notes

1. Additional evidence for long-term priming comes from research on so-called *earworms*, which refer to situations when a particular song or melody comes to mind repeatedly and is difficult to get rid of (Beaman & Williams, 2010; Halpern & Bartlett, 2011; Hyman et al., 2013; Liikkanen, 2012; Williamson et al., 2012).
2. Out of 11 schizophrenia patients, three did not complete the diary on their first attempt. One participant recorded mostly current thoughts instead of mind-pops and two other participants said they were unable to complete the task because they found it difficult to fill in questionnaires. All three participants were willing to try the task again and successfully completed

the diary on their second attempt. However, two of these participants recorded only the contents of their mind-pops and time of their occurrence and did not complete the questionnaires for their recorded mind-pops.

3. Very few mind-pops were recorded in the form of a 'check mark'. Three participants in the control group recorded 1 tick each. In the schizophrenia group, three participants recorded 3, 4 and 6 ticks, respectively. This indicates that the vast majority of mind-pops were recorded in full by both groups of participants.

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